A New Micro-Computer Based Model for the Prediction of LOI

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Many aspects of utility operation affect the level of unburned carbon in fly ash (LOI), including coal selection, blending, pulverizer operation / maintenance, burner balancing, load, excess air, etc. Utility options for managing LOI problems include pulverizer upgrades and intelligent coal selection, and the ability to assess the effect of these options prior to commitment of funds would be useful.

EPRI is engaged in an effort to develop computationally efficient computer models on PC-platforms to aid utilities in evaluating various options for managing LOI. This paper describes one of those products, a micro-computer-based model specially designed to assess the effects of coal selection / switching on LOI. The new code is based on fundamental char combustion kinetics developed under DOE funding (the Carbon Burnout Kinetic model, CBK[1]) coupled to simple descriptions of grinding behavior and furnace environments. The model is designed to make predictions based on readily available coal analyses (proximate, ultimate, HGI) and simple user input only, all handled through a graphical user interface. A flow chart of the logic used by the new code is shown in Figure 1.

The user first specifies standard fuel analyses for a "baseline" coal, along with a baseline LOI value. (The model uses this information to set calibration constants in the furnace submodel.) The user then specifies any number of test coals to be evaluated, along with their standard analyses (proximate, ultimate, HGI). The LOI predictor estimates the particle size distribution from mill correlations, while the NO_x predictor provides an estimate of char yield (1- volatile yield). When changing coals, the user has the option to leave the size distribution unchanged from the baseline case, or to update it using on mill correlations based on calorific value, throughput, HGI, and fineness. The complete particle size distribution is determined from the Rosin-Rammler equation using a constant top size model, as suggested by Unsworth[2].

The char particles of known size and mass are then passed through the precalibrated boiler environment one at a time and their combustion rates and extents of burnout calculated by the kinetics package, CBK. The CBK model is a char combustion kinetics package developed at Brown University and Sandia National Laboratories specifically designed to address the carbon burnout problem, incorporating thermal annealing effects (believed to be important in full-scale furnaces), statistical kinetics, and ash inhibition[1].

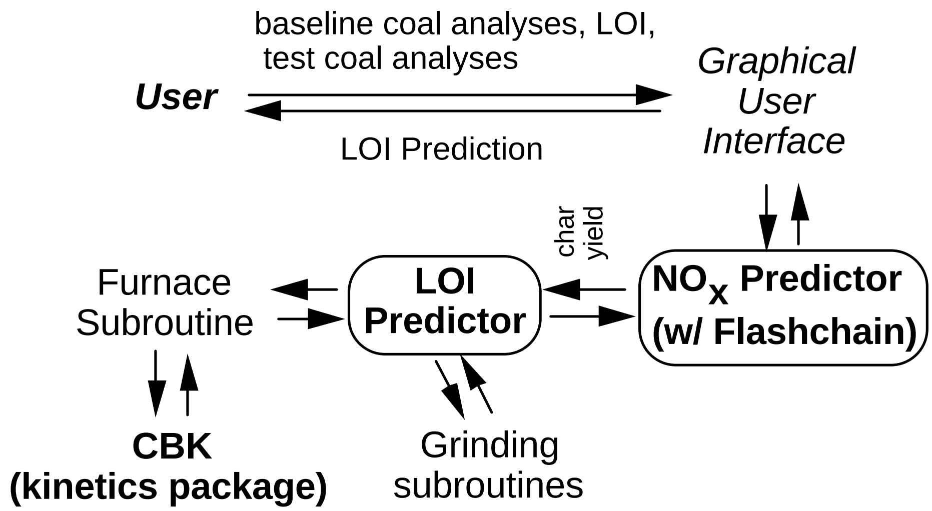

Figure 1. Flow of Logic for the Prediction of LOI

The combined effect of these three mechanisms is to significantly reduce char reactivity in furnaces, especially in the late stages of combustion, consistent with recent observations[3]. The reactivities and physical properties of the chars are estimated from the standard coal analyses using new correlations specifically developed for applicability to a wide spectrum of international coals. Summing over all particle classes gives a prediction of LOI for the unit, which is passed back through the subroutines to the user.

The LOI Predictor code is designed to be computationally efficient, running individual prediction cases in less then five seconds on a 166 MHz Pentium PC, enabling many different test coals to be screened in one sitting. The CBK model has been validated against drop tube furnace data and entrained flow reactor data on about 20 coals. The LOI predictor has been tested against 1 MW pilot scale data supplied by PowerGen on a set of international coals, using known particle size distributions as inputs (see Fig. 2). Full-scale testing and validation of the new LOI predictor code is underway. Initial results are promising, with the correct trends in LOI predicted in almost every case. Beta testing is slated to begin in the spring of 1997.

References

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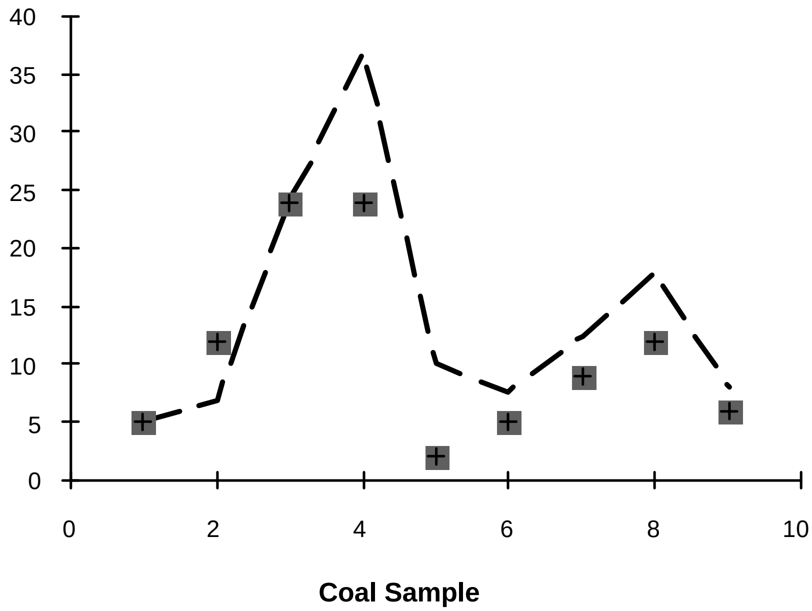

Figure 2. Comparison of model predictions (dashed lines) with LOI values measured in PowerGen 1 MW pilot-scale furnace tests (squares) for a suite of international coals.